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ABSTRACT

The data presented in this report come from the Bureau of the Census in the annual Survey of Industrial Research and Development. Information includes: (1) R&D expenditures by U.S. firms rose 12% between 1977 and 1978 to a total of $33.4 billion; (2) the increases in U.S. industrial R&D activity reflected in R&D funding were confirmed in employment data which showed an increase of 6% in the full-time-equivalents (FTE) of industrial scientists and engineers engaged in research and development; (3) company-funded R&D, when related to net sales, has shown a high degree of stability over time; and (4) there has been an 18% annual rise in industrial R&D expenditures for energy. (SA)

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SCIENCE RESOURCES STUDIES HIGHLIGHTS

NATIONAL SCIENCE FOUNDATION WASHINGTON, D.C. 20550 FEBRUARY 28, 1980 NSF 80-300

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Greatest Increase in 1978 Industrial R&D Expenditures Provided by 14% Rise in Companies' Own Funds

The statistical data presented in this report were collected for the National Science Foundation by the Bureau of the Census in the annual Survey of Industrial Research and Development. Remarks attributed to company officials were based on discussions with several of the leading R&D-performing companies in the major industries.

Highlights

- R&D expenditures by U.S. firms rose 12 percent between 1977 and 1978 to a total of $33.4 billion. After adjusting for inflation, industrial R&D spending grew 4 percent, somewhat less than the real growth reported in the previous two years (5 percent and 6 percent). Nearly eight-tenths of the 1978 increase came from industry's own funds. A number of industrial R&D directors stated that this was an indication of renewed emphasis by corporate management on research and development as a source of corporate growth. Forward budgeting data for 1979 indicate that firms planned a 12-percent increase in their company research and development.

- The increases in U.S. industrial R&D activity reflected in R&D funding were confirmed in employment data which showed an increase of 6 percent in the full-time-equivalents (FTE) of industrial scientists and engineers engaged in research and development (table 1).

- Nearly every industry category shared in the 14-percent increase (6 percent in constant dollars) in R&D spending from companies' own funds. The slowdown in Federal funding for Department of Defense (DOD)- and National Aeronautics and Space Administration (NASA)-sponsored industrial R&D projects was the major factor behind the lack of any real growth in Federal R&D funds in 1978.

- Company-funded research and development, when related to net sales, has shown a high degree of stability over time. Since 1966, this ratio has remained at, or very close to, 2.0 percent, indicating that R&D activities have generally held their own in competing for available company resources.

- Industrial R&D expenditures for energy reached $4.1 billion in 1978, an 18-percent annual rise. Federal energy R&D funding of industry rose at a faster rate—increasing 28 percent during the year. A shift away from nuclear research and development was observed as spending in this area rose more slowly than in any other energy category. The largest increase in company R&D funds was in fossil fuels, while Federal spending made the largest gain in the "all other" category, which includes research and development in solar and geothermal energy.

- U.S. companies increased their R&D expenditures abroad 17 percent between 1977 and 1978, the largest increase since this data series began in 1974. This resulted largely from increased efforts by companies to develop products directed toward local markets, particularly in the petroleum, aircraft, instruments, and drug industries.

Total R&D Funds, 1978

Industrial R&D performance grew 12 percent between 1977 and 1978 (4 percent in constant dollars) to a total of $33.4 billion, sparked by a 14-percent rise in companies' own R&D funds. After several years of fluctuating growth patterns resulting in an overall net reduction in real R&D spending, industrial R&D performance has shown three years of successive real growth since 1975, averaging 5 percent a year. Real growth in company funds has also been reported each year since 1975, averaging 6 percent per year (chart 1). Industrial R&D officials have attributed this development to several factors. The companies are spending more for energy and pollution abatement R&D projects. Increases in these areas accounted for about one-fifth of the industrial R&D gains since 1975. It was also noted that the rise partially results from R&D projects designed to meet government regulatory requirements, although company officials agreed that these projects were usually necessary. For example, a 1977 survey of firms in the

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Prepared in the Industry Studies Group, Division of Science Resources Studies

APR 17 1980

Table 1. Selected industrial R&D data

(Dollars in millions)

Industry	SIC code	Total R&D funds		Federal R&D funds		Company R&D funds		R&D scientists & engineers	
		1977	1978	1977	1978	1977	1978	Jan. 1978	Jan. 1979
Total		$29,933	$33,406	$10,525	$11,301	$19,408	$22,105	405,000	429,800
Food and kindred products	20	398	431	(1)	(1)	(1)	(1)	7,000	7,400
Textiles and apparel	22,23	82	87	(1)	(1)	(1)	(1)	1,700	1,900
Lumber, wood products, and furniture	24,25	127	136	0	0	127	136	2,500	2,500
Paper and allied products	26	337	394	(1)	(1)	(1)	(1)	6,500	7,300
Chemicals and allied products	28	3,261	3,594	299	361	2,962	3,233	48,200	49,700
Industrial chemicals	281-82, 286	1,663	1,814	283	348	1,380	1,466	21,200	21,600
Drugs and medicines	283	1,157	1,281	(1)	(1)	(1)	(1)	18,900	19,900
Other chemicals	284-85, 287-89	441	499	(1)	(1)	(1)	(1)	8,100	8,200
Petroleum refining and extraction	29,13	920	1,071	76	119	844	952	9,900	10,800
Rubber products	30	488	504	(1)	(1)	(1)	(1)	7,800	8,100
Stone, clay, and glass products	32	287	331	(1)	(1)	(1)	(1)	5,100	5,300
Primary metals	33	531	546	24	28	507	518	8,100	8,200
Ferrous metals and products	331-32,3398,3399	260	264	4	5	256	259	3,600	3,700
Nonferrous metals and products	333-36	271	282	20	23	251	259	4,500	4,500
Fabricated metal products	34	393	397	45	36	348	361	7,200	7,300
Machinery	35	3,952	4,459	569	583	3,383	3,876	58,100	63,000
Office, computing, and accounting machines	357	2,763	3,126	546	552	2,217	2,574	39,200	42,800
Electrical equipment and communication	36,48	5,928	6,743	2,693	2,976	3,235	3,767	85,500	89,200
Radio and TV receiving equipment	365	61	54	0	0	61	54	800	800
Electronic components	367	746	834	(1)	(1)	(1)	(1)	2,400	2,600
Communication equipment and communication	366,48	2,804	3,252	1,202	1,372	1,602	1,880	40,400	43,000
Other electrical equipment	361-64,369	2,317	2,603	(1)	(1)	(1)	(1)	30,000	30,100
Motor vehicles and motor vehicles equipment	371	3,324	3,783	438	449	2,886	3,334	30,700	33,500
Other transportation equipment	373-75,379	121	131	(1)	(1)	(1)	(1)	14,300	15,300
Aircraft and missiles	372,376	7,089	7,680	5,526	5,821	1,563	1,859	81,500	86,200
Professional and scientific instruments	38	1,466	1,689	159	174	1,307	1,515	22,100	23,900
Scientific and mechanical measuring instruments	381-82	373	452	10	10	363	442	7,800	8,700
Optical, surgical, photographic, and other	383-87	1,093	1,237	149	164	944	1,073	14,300	15,200
Other manufacturing industries	21,27,31,39	250	280	5	9	245	271	4,600	4,900
Nonmanufacturing industries	07-12,14-17, 41-47,49-67, 737,739,807,891	978	1,152	466	547	512	605	16,100	18,000

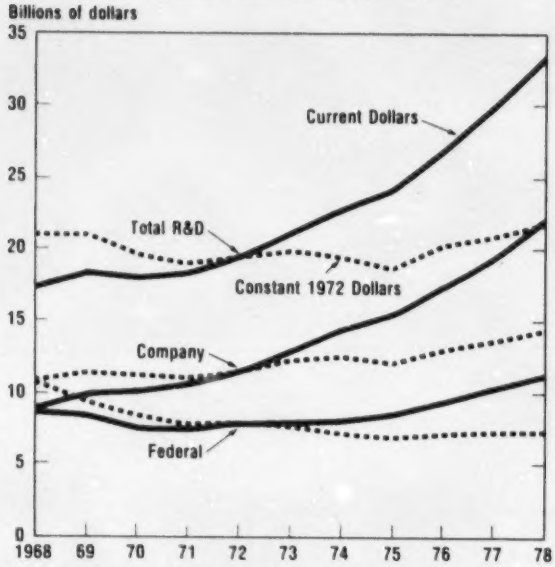
[1] Not separately available but included in higher level totals.

SOURCE: National Science Foundation.

aircraft and missiles industry revealed that about 5 percent of their company-funded R&D resources were devoted to noise abatement and emission control projects that would not have been undertaken in the absence of government regulations. More importantly, however, R&D directors, in a series of interviews conducted by NSF staff, attributed much of the increase to a changing attitude on the part of corporate management toward research and development. In the past, company officials were more likely to tie R&D funding decisions to short-term profit-oriented goals. Now, R&D directors claim that top management is placing greater emphasis on the role of research and development in long-term company growth.

Federal R&D funds to industry rose 7 percent between 1977 and 1978, essentially keeping even with inflation. Increases in Federal R&D funds for energy (28 percent) were offset by declines in funds provided by DOD and by NASA, the latter mostly for the space shuttle. The two largest industry performers of Government research and development—aircraft and missiles, and electrical equipment and communication—registered increases in Federal R&D funds of 5 percent and 11 percent, respectively. Both industries are active in providing spacecraft, weaponry, and military aircraft to the Federal Government. The electrical equipment industry remains active in the energy area, administering four federally funded research and development centers (FFRDC's) primarily devoted to this activity. Energy R&D funds accounted for one-third of the 1977-78 increases in Federal dollars for industrial research and development.

Chart 1: R&D performance by industry



[1]The GNP implicit deflator was used to convert from current to constant dollars
SOURCE: National Science Foundation

Five industries—aircraft and missiles, electrical equipment and communications, machinery, motor vehicles, and chemicals—continued to dominate industrial R&D performance in 1978. There has been a change, however, in the degree of concentration of R&D expenditures among industry groups, with the two leading industries—aircraft and missiles, and electrical equipment and communication—dropping from 57 percent of all R&D funds in 1968 to 43 percent 10 years later. The other three leading industries each commanded approximately 9 percent of the R&D market in 1968. By 1978 machinery had increased its performance to 13 percent of all industrial research and development in the country. Motor vehicles and chemicals each accounted for approximately 11 percent.

Forward budgeting data for 1979 collected in the 1978 survey indicated that companies planned a 12-percent increase in their company R&D funds in 1979. The aircraft and missiles and electrical equipment industries projected the largest increases, 22 percent and 16 percent, respectively. R&D officials largely based this optimistic 28-percent projected increase on an upturn in Government R&D support, a major determinant of company R&D spending in that industry.

R&D Funds as a Percent of Net Sales

The ratio of R&D expenditures of U.S. manufacturing firms relative to their net sales figures was 3.0 percent in 1978, essentially unchanged since 1974. This level is markedly below the 1963 peak of 4.5 percent, and the decline reflects the leveling off of Federal R&D funding in both defense- and space-related areas, particularly in the aircraft and missiles industry.

A different picture emerges, however, when Federal funds are excluded from the R&D/sales ratio. Relating companies' own funds to net sales provides an indication of how R&D budgets are doing relative to the many other activities that compete for a firm's total resources.

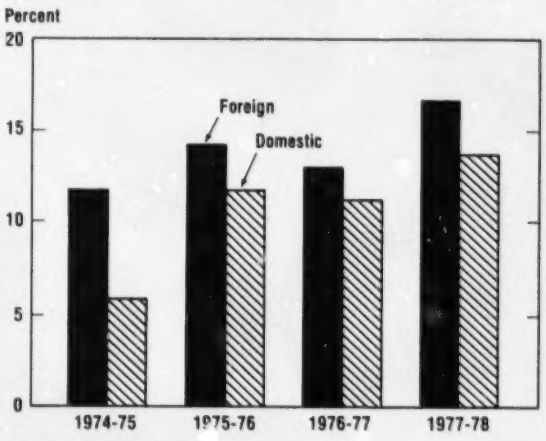
For all manufacturing industries, this picture is one of long-term stability, with the ratio staying at 2.0 percent since 1972 and varying no more than two-tenths percent since 1966. In other words, company-funded R&D programs appear to have held their own over the years against other demands for company resources.

R&D Performed Abroad by U.S. Companies

Company-funded R&D expenditures in foreign countries by U.S. firms increased at a rapid 17-percent rate in 1978, well above the 13-percent annual average for the prior three years, spearheaded by increases in the petroleum, aircraft and missiles, instruments, and chemicals industries (table 2). The petroleum industry's rise primarily resulted from an acquisition by a major performer in this group; the other industries increased their programs either in response to gains in foreign sales or as an attempt to expand their foreign operations.

In 1978 foreign R&D spending by U.S. firms amounted to 10 percent of industry's company R&D funds. Among individual industries, the ratio varied from under 2 percent for nonmanufacturing industries to over 12 percent for the machinery and chemical's industries. Since this series began in 1974, the rate of increase in foreign R&D spending has been somewhat higher than that of domestic R&D spending (chart 2). This is in part a result of spending by the machinery and chemicals

Chart 2. Relative increase in foreign and domestic company-financed R&D expenditures of U.S. firms



SOURCE: National Science Foundation

Table 2. Company research and development performed by foreign affiliates outside the United States by selected industries: 1978

(Dollars in millions)

Industry	Total performed by foreign affiliates	Relative increase from 1977	Company funds spent by foreign affiliates as a percent of company funds spent within the U.S.
		Percent	
Total	$2,166	17	10
Chemicals and allied products	396	19	12
Petroleum refining and extraction	87	43	9
Machinery	469	13	12
Electrical equipment and communication	327	14	9
Aircraft and missiles	57	30	3
Professional and scientific instruments	67	26	4
All other	763	15	11

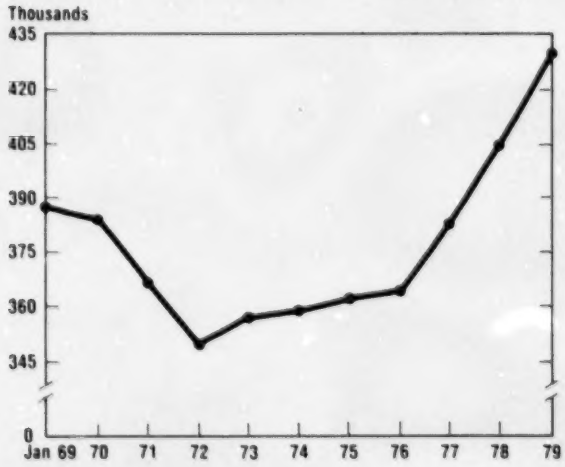
Source: National Science Foundation

industries, the foreign R&D programs of which have increased at a significantly faster rate than their domestic efforts.

R&D Scientists and Engineers

Accompanied by continued constant-dollar growth in industrial R&D expenditures, the number of FTE R&D scientists and engineers employed by industry rose 6 percent from January 1978 to January 1979 to an all-time high of 429,000 (chart 3). Industry's employment of R&D scientists and engineers has risen at a rate of 3 percent per year since January 1972. Not surprisingly, the major R&D-performing industries with the largest personnel gains were those with the largest increases in funds—motor vehicles, petroleum, machinery, and instruments.

Chart 3. FTE[a] R&D scientists and engineers in industry



[a]Full-time-equivalent
SOURCE: National Science Foundation

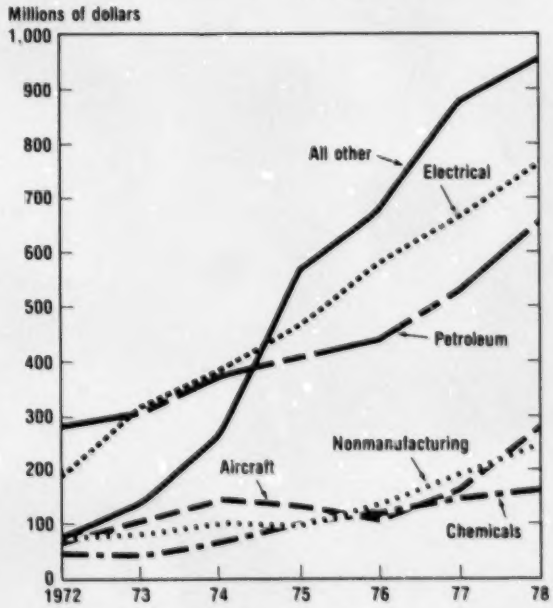
Energy Research and Development

Industrial R&D expenditures for energy—a major factor in the 1975-78 increases in industrial research and development—reached $3.1 billion in 1978, a gain of 18 percent (10 percent in constant dollars) over the previous year (chart 4). The rise is a result of increased Federal and company funding for energy, reflecting an awareness of research and development's potential role in alleviating U.S. energy problems. According to company officials, 1979 expenditures were expected to reach $3.4 billion, a 10-percent increase, maintaining a small edge on inflation.

The electrical equipment industry continued to lead all other industries in energy R&D expenditures, with $767 million in 1978. Its efforts are largely federally supported (74 percent), and are nuclear-intensive, in large part because of the work of the FFRDC's sponsored by the Department of Energy.

The petroleum industry was second in energy R&D spending in 1978, with a 22-percent increase to a total of $655 million. In contrast to the electrical equipment industry, 72 percent of the energy research and development performed by the petroleum industry is company-funded. The emphasis has been primarily in the fossil fuels area, particularly in synthetic fuels and oil.

Chart 4. Expenditures for energy R&D performance: selected industries

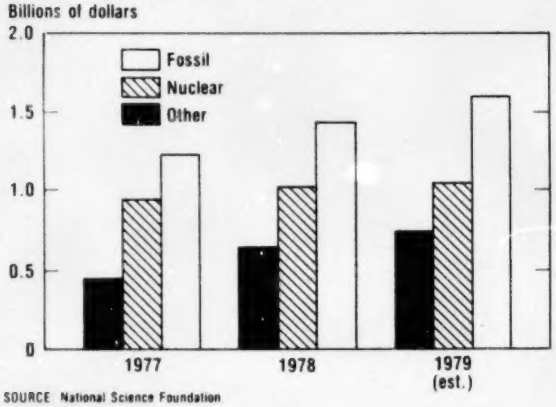


SOURCE: National Science Foundation

The aircraft and missiles industry with nearly three-quarters of its energy research and development supported by Federal funds, increased its energy R&D expenditures by 72 percent between 1977 and 1978 to a total of $284 million. Much of this effort is in the "other energy" category, especially energy conservation.

Nuclear energy R&D expenditures by industry increased only 8 percent in 1978, just barely staying even with inflation. Only a 3-percent rise has been planned for 1979. Fossil fuels comprise the largest energy category and registered a 17-percent increase between the two years, as a result of an increase of nearly 50 percent in Federal support. Most of the Federal funding in this area has been provided for coal research and development, particularly synthetic fuels. The other energy category showed a 42-percent rise with a near-doubling in its federally supported effort. This points out the increased emphasis being placed both by industry and the Federal Government on alternative sources such as solar and geothermal as well as on energy conservation research and development (chart 5).

Chart 5. Industrial R&D expenditures for energy by primary energy source



SOURCE: National Science Foundation

Pollution Abatement Research and Development

Industry's pollution abatement R&D expenditures rose 18 percent to a 1978 total of $1.1 billion. The motor vehicles industry spent over one-half this amount, $605 million, in its effort to meet government emission standards by the early eighties. Other major performers include the nonmanufacturing sector, the chemicals industry, and the petroleum industry.

Nonmanufacturing pollution abatement R&D funds are spent primarily by electric and gas utilities. Increases in this sector for 1978 were primarily attributable to projects designed to control power plant emissions.

The petroleum industry registered an 18-percent increase in its pollution abatement research and development between 1977 and 1978 which its R&D directors have attributed to the effect of the Toxic Substances Control Act. This legislation, enacted in 1977, primarily affects chemical-related industries. On the other hand, the chemicals industry itself held its pollution R&D program steady in 1978 but anticipates a large (25 percent) increase in 1979.

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Research and Development in Industry, 1978 (Detailed Statistical Tables) will be published later this year. A final analytical report is published biennally; the next issue will report on data from the 1979 survey. *Highlights* and Tables are published each year and are available from the National Science Foundation, Washington, D.C., 20550.